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REGIONAL SAMPLING IN A FORESTED SITUATION:

ARCHAEOLOGY AND THE NORTHEAST COAL STUDY

by

Bruce Frederick Ball

B.A. (Hons.) Simon Fraser University 1975

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in the Department

of

Archaeology

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April 1980

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Regional Sampling in a Forested Situation:

Archaeology and the Northeast Coal Study

Author: _____
(signature)

Bruce F. Ball
(name)

April 21, 1980
(date)

APPROVAL

Name: Bruce Frederick Ball

Degree: Master of Arts

Title of Thesis: Regional Sampling in a Forested Situation:
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Examining Committee:

     Chairman: Richard Shutler Jr.

Jack D. Nance
Senior Supervisor

Knut R. Fladmark

Bjorn O. Simonsen
External Examiner
Head, Archaeology Division
Heritage Conservation Branch
Ministry of the Provincial Secretary
and Government Services
Victoria, British Columbia

Date Approved: April 18, 1980

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ABSTRACT

Archaeological survey results from northeastern British
Columbia are presented. Data collection was based on a
regional sampling scheme undertaken for the Northeast Coal
environmental study. Problems of heritage resource evaluation
in such vast forested regions as the Northeast Coal study area
are viewed as being best served through implementation of
formal sampling techniques.

Ecological anthropology and sampling theory provide the
theoretical and methodological bases for the study and are
reviewed to emphasize some of the problems and considerations
in the design of the research. As well, the concept of
cultural resource management is briefly discussed to impart
some insight into the difficulties normally associated with
cultural resource management studies.

Results are presented from: 1) A pilot survey undertaken
as a test of the sampling scheme as well as to provide
information on the characteristics of the region; and, 2)
Survey sampling in a control corridor area of the study region.
These latter results are used to make predictions about

heritage resource potential in 29 other portions of the study area. Similarity among 32 corridor areas is determined through comparison of 20 environmental attributes scored for each of the respective areas.

Results of the survey and comparison suggest that 19 of the 29 corridor regions have some potential for containing heritage resources. Heritage resource potential of these 19 regions is shown by the degree of similarity displayed between them and the three strata of the survey sampling control area.

Nothing here but history
Can you see what has been done

(Fagen and Becker 1976)

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Several members of the Department of Archaeology were most helpful. Roy Carlson was instrumental in providing me the opportunity to undertake research on the Northeast Coal block and was supportive and encouraging throughout the study. Herb Alexander was influential early in my quest for grants and permits and Brian Hayden provided stimulus and encouraged

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Chapter 1

INTRODUCTION

The Study

   This thesis presents results of archaeological research

undertaken in a vast forested portion of northeastern British

Columbia. The main purpose of the work was to evaluate the

extent and nature of heritage resources in the Northeast Coal

Block (Fig. 1) as part of an environmental impact assessment

and development design program. Overall the Northeast Coal

(N.E.C.) study was organized and administered by the British

Columbia government's coal committee on northeast coal

devlopment. The committee, formed by the government to oversee

the study, is called the Environment and Land Use Sub-Committee

(E.L.U.S.C.) on Northeast Coal Development. The archaeological

work was under the auspices of the Resource Analysis Branch

(R.A.E.) of the Ministry of the Environment and the Archaeolcgy

Division (now Resource Management Division) of the Heritage

Conservation Branch. Individual programs of the N.E.C. study

were jointly funded by the Ministry of Economic Development,

government of British Columbia and the federal government's

Department of Regional Economic Expansion.

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Figure 1   The Northeast Coal study area.
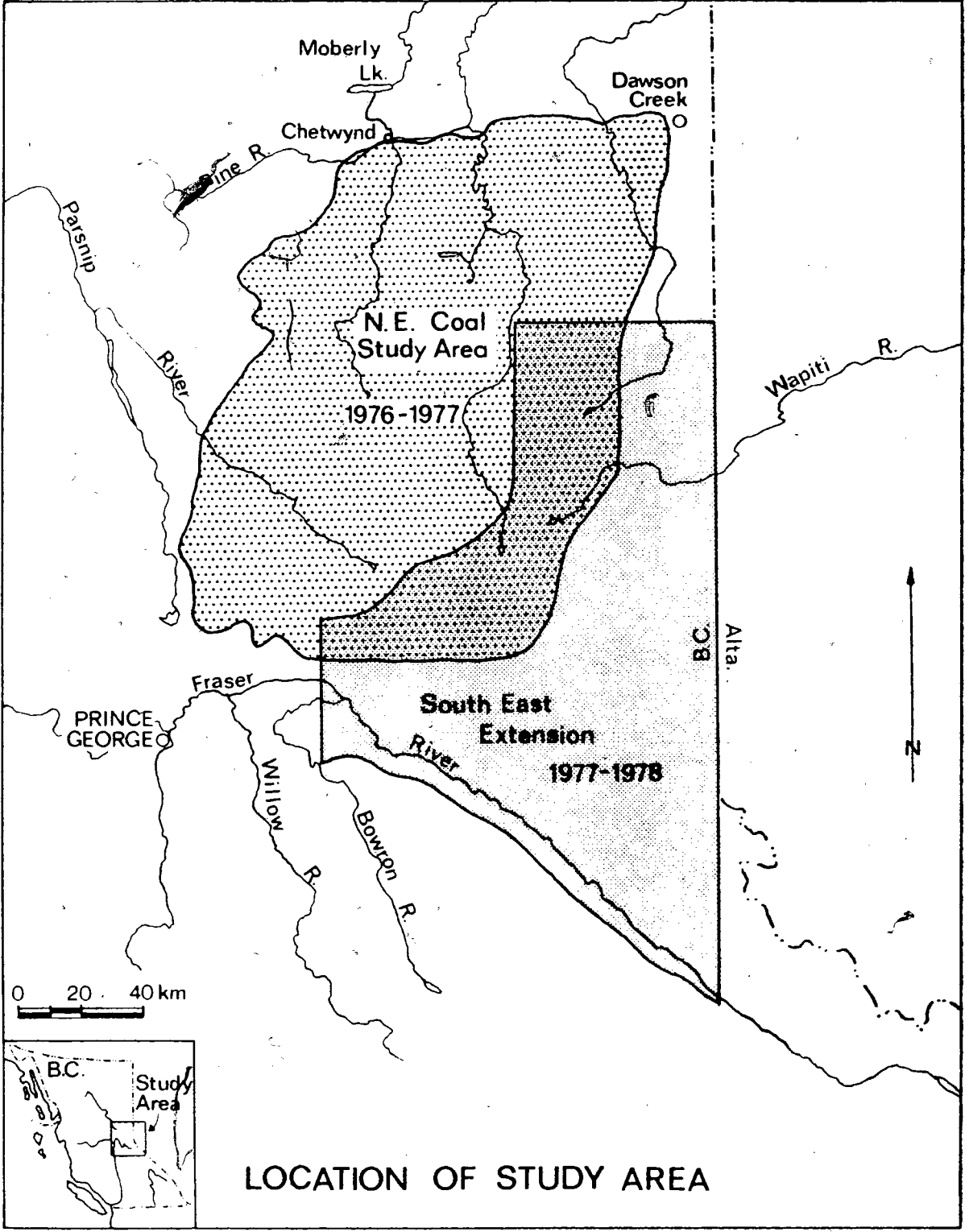
LOCATION OF STUDY AREA

The N.E.C. study was undertaken to acquire ". . . environmental baseline information on the entire Northeast Coal Block" and to ". . . assess environmental impacts of potential road and rail corridor and townsite developments" (E.L.U.S.C. 1978: xxvi). The study included 8 different research components and the results from these different programs provided information for government planning and evaluation purposes. The results of the study are contained in 2 volumes published by the E.L.U.S.C. (1977; 1978). A more detailed presentation of the archaeological research is contained in an unpublished report (Ball 1978) prepared as a supplement to the E.L.U.S.C. reports. This report is on file with the Rescurce Management Division of the Heritage Conservaticn Branch of the Government of British Columbia.

Archaeological research in the Northeast Coal block was carried out during 1976 and 1977. Results of these efforts include inventcry from general survey and sample survey as well as data from a site excavation. A total of 89 sites were recorded in the study area, including 58 prehistoric sites, 29 historic cabin sites and 2 burials. Excavation at GiRi 4 resulted in scant few diagnostic artifacts for comparative purposes but analysis does suggest some similarity exists with the Oxbow Complex of the northern Plains area. A date from the site of 3427 +/- 111 radiocarbon years supports this

interpretation. Artifacts from the eastern portions of the study block support the contention that the culture history of this part of the area is similar to that of the northern Plains region. The body of this thesis, however, is only concerned with the design, method and results of the formal sampling survey undertaken in 1977.

Purpose and Scope

The purpose of this thesis is to present an approach to regional heritage survey in forested areas and, to a lesser extent, to outline some of the difficulties associated with cultural resource management (C.R.M.)-like studies.

There exist a number of problems when attempting to carry out archaeological projects that are C.R.M. oriented. Notwithstanding the fact that most research projects are limited in some way, some of the most compelling problems with C.R.M related work concern potential limitations placed upon the research which are usually a function of contract requirements and schedules. These tacitly and profoundly restrict the type and amount of work that can be satisfactorily carried out. Such limitations compound problems usually accompanying archaeological research and it is felt by some that these limitations provide some basis for questioning the integrity of C.R.M. studies (cf. Plog et al. 1978; Dunnell 1979; Klippel 1979).

The N.E.C. project was implemented as an inventory, planning and evaluation exercise aimed at identifying and controlling any adverse impact of the proposed development on heritage resources. The objectives of the overall N.E.C. study, as defined by the E.L.U.S.C., were:

> . . . to investigate the economic, social and environmental consequences of proceeding with various possible coal mine developments and of providing the transportation links, town facilities and other supporting infrastructural services which these mines would require (E.L.U.S.C. 1977:1).

Commensurate with these ends one of the primary objectives of the project was to evaluate the existence of heritage resources within proposed development zones of the Northeast Coal block. This particular concern provided the impetus for the research presented here.

The scope of this study includes theoretical, methodological and pragmatic aspects which entered into the design of the project. To facilitate an understanding of some of the problems encountered and to provide some general background, a review of the relevant legislation and the concept of cultural resource management is presented. Following this an overview of the results of the project is provided with emphasis placed upon results which were of primary interest to this study.

In the remaining pages of this chapter a general outline of the geographical setting is intended to: 1) Provide some understanding of the vastness and diversity of the study area; and, 2) Define it as a physiographic region (Berry 1968). Chapter II summarizes theoretical and methodological considerations pertinent to the study, along with a discussion of conservation archaeology and legislative guidelines of the provincial government. The research design is presented in Chapter III. In Chapter IV the survey sampling results are provided with a brief discussion cf the statistics used. Chapter VI includes a summary and some concluding remarks.

Environmental Setting

The study area (Fig. 1) is a particularly large tract of land which displays great physical diversity while concomitantly retaining some integrity as a physiographic and climatic unit. The present section is meant to provide an overview of the physical nature of the study area as a means of understanding the problem of evaluating heritage resources within such a region. The study area as defined by the Environment and Land Use Sub-Committee (E.L.U.S.C.) comprises over 37,000 Km² . In 1977, this area was enlarged southwards to include the Southeast Extension study area (Fig. 1), covering

another 19,500 Km^2. These areas are bounded by the Alberta-British Columbia border on the east, the Hart Highway on the north and and the Yellowhead Highway in the south. The research presented here concerns only the northern section, referred to as the Northeast Coal study area.

The Northeast Coal block lies within parts of six physiographic regions (E.L.U.S.C. 1977): the Rocky Mountain Trench; the Rocky Mountains; the Rocky Mountain Foothills; The Alberta Plateau Benchlands; the Alberta Plateau Plains; and the Interior or McGregor Plateau (Fig. 2). All of the major rivers occupy valleys that were glaciated during the Pleistocene. These systems flow in a northeast direction and are part of the Arctic drainage system. They drain the eastern slopes of the Rocky Mountains and flow into the Pine or Smoky Rivers. From these systems, water flows into the Peace River, thence into the McKenzie and finally into the Arctic Ocean.

The study area lies within a broadly defined vegetation zone known as the Boreal Forest. This zone makes up the greater proportion of all forested land in Canada and is characterized primarily by coniferous trees such as white and black spruce, tamarack, fir and pine as well as such deciduous species as birch, aspen and poplar (Rowe 1972). In the study area this forest zone is divided into 3 major forest regions:

Figure 2 Physiographic regions of the study area.

PHYSIOGRAPHIC
REGIONS

ALBERTA PLATEAU PLAINS

Moberly Lake

Chetwynd

Dawson
Creek

Fellers
Heights

Kiskatinaw

Pine   R.

R.

ROCKY

MOUNTAIN   Gwillim
            Lake

FOOTHILLS

Sukunka

River

ALBERTA

PLATEAU

BENCHLANDS

Sentinel
Peak

Murray

Quinette
Mountain

ROCKY

MOUNTAINS

ROCKY MTN
TRENCH

INTERIOR PLATEAU

FRASER

R.

Giscombe
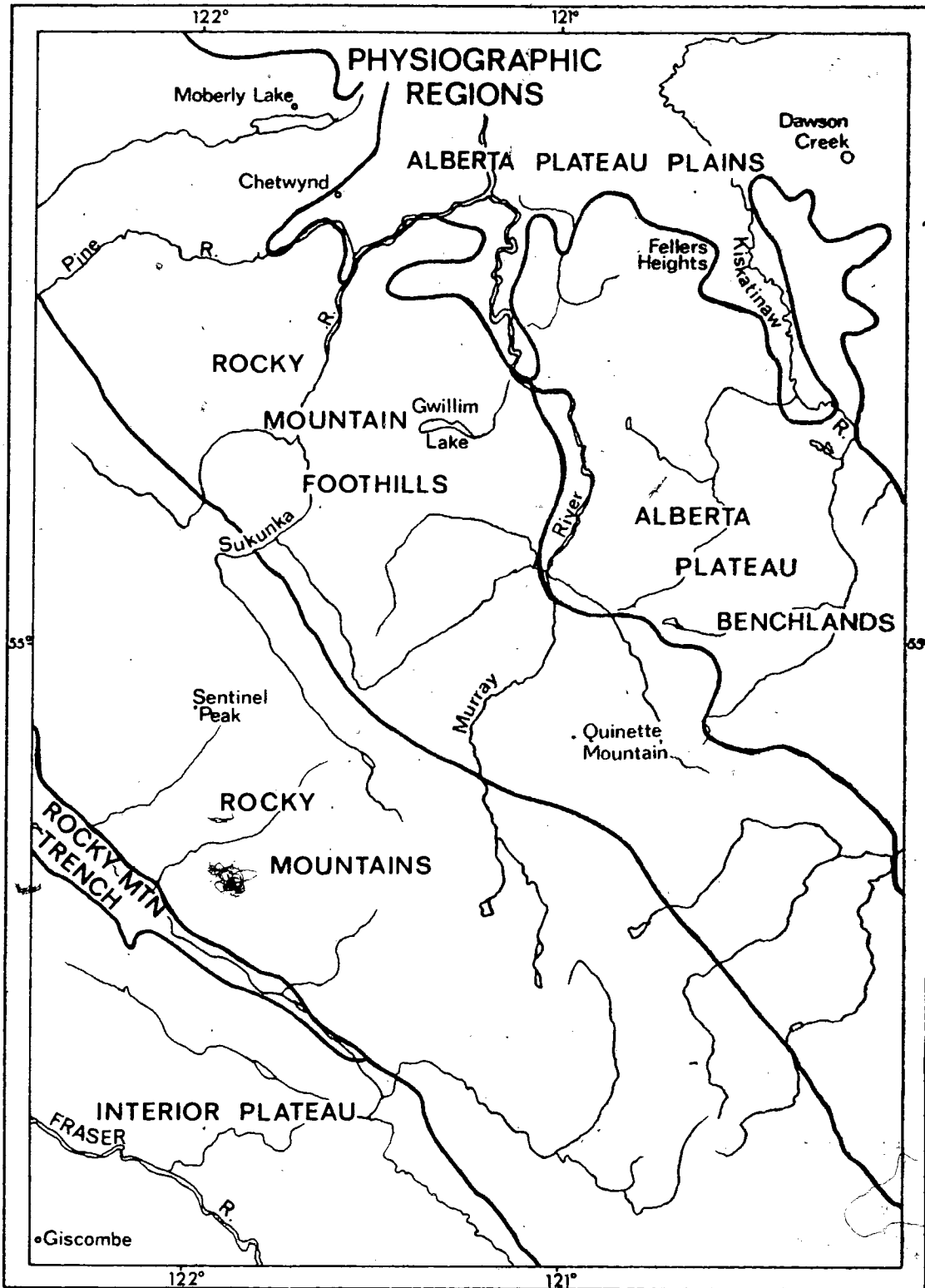
1) Boreal Forest Region; 2) Subboreal Forest Region; and, 3) Interior Region (E.L.U.S.C. 1977:24-28). These are further sub-divided into 5 sub zones (Table I). The basis of the zonation is a system that links vegetation communities which are at various succession stages, but which exhibit similarities in climax potential (Westcoast Transmission 1977: 90-91). These major regions and their respective zones are shown in Table I.

The region is classified as having a cool continental climate with cold winters, warm summers and low precipitation. Storms occur both in summer and winter. The Rocky Mountains are the major factor influencing climatic conditions within the study area but the climate is also greatly affected by terrain; temperature varies with elevation, and the aspect and exposure of an area will influence amounts of precipitation, wind and insolation.

Several glacial advances occurred during the Pleistocene, but the two most recent advances account for most of the surficial deposits currently found throughout the study area. In general, the surficial deposits are classified as either glaciofluvial or morainal. The former are usually found in association with present river systems, while the latter occur between valleys. It is believed that during the Wisconsin glaciation, the glacial ice sheet modified the mountains in the study area,

TABLE I

Major forest regions and sub zones of the

Northeast Coal study area

Region	Zone
Boreal	Boreal White Spruce
	Subalpine Englemann Spruce
	Subalpine Fir
	Alpine Tundra
Subboreal	Subboreal White Spruce
	Subalpine Englemann Spruce-Subalpine Fir
	Alpine Tundra
Interior	Interior Western Hemlock - Western Red Cedar
	Subalpine Englemann Spruce - Subalpine Fir
	Alpine Tundra

(E.L.U.S.C. 1977:24)

rounding the summits of some of the peaks as it moved in a northeastward direction. This accounts for the distinctive character of these mountains; " . . . a subdued alpine topography which is most unlike the familiar Rocky Mountains of the south" (Holland 1964:90).

The description presented here provides only a brief review of a most formidable study domain for heritage resource survey and investigation. Problems related to size and physiographic diversity of the study region are compounded by the fact that previous research in the area was non-existent. More detailed descriptions of the region may be found in the two environmental reports prepared by the Environment and Land Use Sub-Committee on Northeast Coal Development (1977; 1978). The description in this Chapter is meant only to provide overall geographic orientation directed at providing a general understanding of problems encountered in undertaking research in the area.

From the above description it can be easily seen that undertaking archaeological survey in such a large and physiographically diverse area as the Northeast Coal block presents problems. Difficulties encountered in evaluating heritage potential within such a region are complicated by the fact that the survey areas are covered by boreal forest and, therefore, cannot be considered amenable to the usual methods of pedestrian survey.

Chapter 2

THEORETICAL AND METHODOLOGICAL CONSIDERATIONS

Introduction

Explanation and predictions of actual events or phenomena are predicated upon knowledge expressed in sets of assumptions collectively known as theory. The two main bodies of theory relevant to the research undertaken in the Northeast Coal Heritage Project are contained in ecological anthropology and sampling theory. Further direction in the study came in the form of requirements outlined by the contracting agencies, along with the relevant legislation and the concept of cultural resource management (C.R.M.). These latter three factors will be discussed further to present the reader with an understanding of the scope of the project. The discussions on cultural ecology and sampling, on the other hand, are presented as considerations relevant to research design.

Cultural ecology has become one of the salient trends in modern anthropological studies (eg. Hardesty 1977). It embodies a number of major concepts and topics which have

implicitly and explicitly been used in the study of prehistory.
These include ideas about prehistoric ecological systems,
cultural adaptation, population dynamics and carrying capacity
(cf. Casteel 1979; Clark 1972; Hayden 1975; Jochim 1976;
Sanders and Price 1968). Together these concepts have provided
the archaeologist with new and potentially fertile avenues of
enquiry toward understanding and explaining prehistoric
lifeways.

Although principles of probabilistic sampling have long
been known to archaeologists (Binford 1964; Ragir 1967;
Rootenberg 1964; Vescelius 1960), widespread application of
this approach in the study of prehistory is rather recent. The
ultimate objective of sampling is to obtain information about a
large entity by studying only a portion of it. The alternative
to sampling, of course, is to look at the total entity or
population. This is often impossible and is therefore the
primary reason why statistical sampling strategies are useful.
It has been clearly demonstrated in numerous cases that
sampling works. Williams (1978) presents two "celebrated
examples" to exemplify "the proof of the pudding". Both of
these involve extracting reliable information from large
aggregates by sampling and both are important, monetarily, to
the companies involved.

The first example is a plan worked out by the
domestic airlines for allocation of ticket
revenues of passengers using more than one
airline (Dalleck 1959). In such cases revenue
accrues to each of the airlines involved, but
the fare is collected only by one. Traditional
accounting would call for a settlement on an
item-by-item basis. But it is not done this
way; instead it is done on a sample basis. The
reason is that the cost reductions obtained by
processing only a sample of the tickets
outweigh the benefits to any of the airlines of
processing every ticket. The sample is less
than 10% of the total number of involved
tickets and all the participants are happy with
the scheme.

. . . the telephone companies also use
sampling techniques as a basis for their
settlements. There seems to be little reason
to suspect that any company would be involved
in these plans if it were not in its own
interest to do so (Williams 1978:48).

Ecological Approaches

One of the recent trends in archaeological research is the
use of environmental variables in the delineation and
explanation of past cultural manifestations. This approach is
largely attributable to a current direction in anthropological
theory referred to as ecological anthropology (Hardesty 1977).
Although interest in cultural ecology is not a new phenomenon
to archaeology (eg. Flannery 1972; Sanders 1965; Sanders and
Price 1968 Steward 1937;—1955) its influence has been most

noticeable in that portion of the archaeological literature referred to as the "new archaeology". The roots of ecological anthropology, however, lie within that theoretical expression of anthropology known as cultural materialism (Harris 1968; 1979), also referred to as neoevolutionism (eg. King et al. 1977: 27). This is a view which has increasingly influenced archaeological researchers to stress economics and ecology.

> The materialistic conception (Cultural
> Materialism or Neoevolutionism) increased
> interest in economics and ecology, and in this
> field the transition to a systematic mode of
> thought had long been prepared for.
>
> . . . In the study of the economy and of
> ecology, the ground had been prepared for the
> systems approach by the environmental
> archaeologists of the school of Clark . . .
> (Klejn 1977:7).

Ecological anthropology includes several different traditions of environmental explanation, these include cultural ecology, population ecology, systems ecology and ethnoecology.

> In anthropology environment has been used to
> explain cultural origin and diversity in at
> least three ways: environmental determinism,
> environmental possiblism, and ecology. In
> recent years the ecological approach has
> replaced the other two and today is one of the
> most popular kinds of anthropological
> explanations (Hardesty 1977:17).

Following this, archaeology has attempted the explanation of past cultural manifestations by viewing both the site specifically as well as the site within its environmental context.

> . . . such environmental components as climate, vegetation, faunal species, and various raw materials are integral aspects of the archaeological record and constitute an important portion of the cultural resource base. Archaeological and environmental information function symbiotically to provide the maximum interpretation potential for explaining patterns of human adaptation through time (Broilo and Judge 1977:2).

There exist numerous examples of this influence in archaeological research (cf. Baumhoff 1963; Birdsell 1953; Casteel 1979; Sanders 1965; Sanders and Price 1968; Sneed 1971 Washburn 1974). Perhaps one of the more influential figures to promote the ecological approach in archaeology was Julian Steward (Steward 1937).

> To a marked degree, Steward's image of what archaeology should have been doing in the 1930's has come true in the fifties and sixties. The dominant orientation in contemporary American anthropological archaeology now conforms to Steward's understanding of cultural ecology (Harris 1968:684).

Current models of man-environment relationships see the environment as either an uncreative limiting factor

(possibilism) or " . . . that recognize complex mutual
interaction between the two" (cultural ecology) (Hardesty
1977:3). Using the latter point of view, archaeologists have
utilized environmental variables as a means of predicting or
explaining prehistoric cultural patterns and lifeways. One
criticism of this approach is that it represents an expression
of environmental determinism, a view which sees cultural
behaviour and biology as a direct result of environmental
forces. But environmentalism sees the physical environment
only as the "prime mover" whereas cultural ecology presumes
mutual interaction. It is this interaction which justifies the
utilization of environmental attributes to aid in the
description and explanation of past cultural behaviour.

Survey Sampling

Sampling is a process of selecting a portion of an
aggregate to obtain information about and make inferences about
the whole of that aggregate. Examples of simple sampling
procedures are found in many daily situations whereby small
parts of a whole are taken to be representative of that whole.
Sampling is more complex in some instances than in others and
consequently different sampling designs exist. The ultimate
objective of any sampling scheme is to acquire accurate and

precise information about the population under consideration. Success is largely dependent upon the application of an appropriate sampling design.

Kish (1965:18-19) identifies two different kinds of sampling, model sampling and probabilistic sampling. In the former, sampling is based on broad assumptions concerning the distribution of the survey variables, while in the latter, inferences regarding the population about which information is sought are based on statistical theory rather than assumptions. Parenthetically, it is interesting to note that survey sampling theory is different from classical sampling theory in that the populations in survey sampling contain finite numbers of units and in classical sampling they are not. "The methods to prove the theorems are different and the results [of survey sampling] are more complicated" (Cochran 1963:9) . . . than in classical sampling theory.

In model or non-probabilistic sampling, bias usually occurs as a result of poor selection methods (Cochran 1963: 10-11; Kish 1965: 18-21; Yates 1960: 9-17). But, while probabilistic sampling also contains errors, they are usually substantially less severe in that they may be identified or estimated. For example, if a simple random sample of projectile points shows that the average length is 7.5 cm with a standard error of 2.06 cm at 95% confidence (Thomas 1976:

232-233) the chances are 95 in 100 that the interval:

$$7.5 \text{ cm} + (1.96)(2.06) \text{ cm} = 11.54 \text{ cm}$$

and $$7.5 \text{ cm} - (1.96)(2.06) \text{ cm} = 3.46 \text{ cm}$$

will encompass the true average length of projectile points in the population, assuming a "sufficiently large" sample of points.

This implies that if the same formal sampling scheme were repeatedly applied to these data, 95% of the resulting mean estimates would lie within 3.46 cm and 11.54 cm and 5% would not (cf. Cochran 1963; Deming 1960; Hansen, Hurwitz and Madow 1953; Kish 1965).

The primary advantages of sampling over complete inventory are usually identified as: 1) Reduced cost; 2) Greater speed; 3) Greater scope; and, 4) Greater accuracy (Cochran 1963:2; Kish 1965:18). Expressed another way, the primary purposes of probabilistic sampling are: 1) To obtain an unbiased sample of elements; 2) To estimate population parameters; and, 3) To estimate the probable error of the parameter estimates. In archaeological survey, as in other types of survey, these provide a number of advantages over non-probabilistic procedures.

In sampling, two distinct groups are of interest; the sample and the population. The population consists of the aggregate of units about which information is sought and from which the sample is chosen. A further distinction is possible between the sampled population and the target population. The target population represents that aggregate of units about which information is sought and the sampled population is that which is actually available for sampling. The target population may be either real or hypothetical but more importantly, it must be definable. Ideally, the two should be the same if the target population is accessible, but if this is not the case then inferences must apply to the sampled population alone (Cochran 1963: 6).

In some instances the terms universe and population are interchangeable. However, there exist some problems in that the universe usually refers to a more hypothetical set of elements (Kish 1965: 7; Chenhall 1975: 5-6). The use of the term universe should therefore be restricted to a hypothetical infinite set of units, different from the population.

The members of a population are termed elements. Kish defines the population jointly with the elements: " . . . the population is the aggregate of the elements, and the elements are the basic units that comprise and define the

population" (Kish 1965: 7). The element is therefore the basic unit about which information is required.

In some instances the element may be the same as the sampling unit. However, it is useful to make a distinction between the two in that the elements usually belong to the sampling units: "Sampling units contain the elements, and they are used for selecting elements into the sample" (Kish 1965: 8). Cochran notes that the sampling units " . . . must cover the whole of the population and they must not overlap, in the sense that every element in the population belongs to one and only one unit" (1965:7). It is possible to have sampling units which contain several elements. When the sampling procedure involves selection of sampling units containing more than a single element, the elements are selected by cluster sampling.

In element sampling, each sampling unit contains only one element, but in cluster sampling, any sampling unit called a cluster may contain several elements. For example, a sample of students may be obtained from a sample of classrooms, or a sample of dwellings from a sample of blocks. The same survey may use different kinds of sampling units, and in multistage sampling a hierarchy of sampling units is used, so that the element belongs to one sampling unit at each stage. For

example, a sample of persons in a province may be taken by successively selecting districts, municipalities, townships, dwellings and finally persons. The population is also an aggregate of the sampling units, specified for each stage (Kish 1965: 8).

These distinctions can be illustrated by the following. If an archaeological survey is required in an area to determine number of sites present, the decision might be made to employ formal sampling procedures through examination of randomly selected quadrats, for example. The basic unit about which information is sought is the site and the site is therefore the element. The target population is the aggregate of sites within the specified sample area. However, because it is the area which will be sampled a distinction is made between the elements (sites) and the observational units (quadrats) and between the target population and the sampled population. The target population comprises the sites about which information is sought and the sites actually found are cluster samples from the population, if random samples of quadrats are drawn. The elements are the sites actually found within the observational units. The sampling units will be observed to obtain information about the elements (sites) and ultimately the target population.

The target population would be the totality of all sites within the defined sampling area. The sampled population would be those sites that are actually accessible for sampling. For instance, sites which are covered by glacial deposits would be inaccessible for surface survey. In such a case the target population would not contain the same set of elements (sites) as the sampled population.

There exist three different spatially defined units of observation: 1) Points; 2) Lines or transects; and, 3) Small areas or quadrats (Berry 1962; Berry and Baker 1968). Of these, the transect and quadrat types have been used most frequently in archaeological research (cf. Judge et al. 1975; Matson and Lipe 1975; Mueller 1974). Point sampling has been used more often in geographical research where the variables under consideration are continuous variables such as land uses or field crops (eg. Yates 1962; Berry 1962; Berry and Baker 1968).

In probabilistic sampling each element has a known probability of selection and the basic selection process is known as simple random sampling. There exist many different versions of this basic process which may be used to provide more " . . . practical, economical, or precise designs" (Kish 1965:21). And, sampling schemes are usually designed to

meet very specific problems. In this respect, Williams notes
that " . . . the art of sampling is to pick a sampling
scheme to fit the specific characteristics of the target
population (Williams 1978: 148).

Stratification is a technique often used in sampling to
improve the efficiency of the sampling design. The purpose of
stratification is to insure " . . . that the full
variability that exists within a survey area is expressed in
the sample" (Mueller 1974: 33). The population of sampling
units is divided into subpopulations using criteria which are
related to the objectives of the study, for example
environmental criteria. The basis for stratifying an area may
be prior knowledge of the area, or an assumption that each of
the strata are internally more homogeneous than the population
taken as a single unit. In a stratified sample, each of the
strata must be non-overlapping, that is, each unit can belong
to one and only one stratum and each stratum is sampled
independently.

Another technique commonly used to increase sampling
design efficiency is subsampling or multistage sampling.
Although subsampling has not seen widespread use in the
archaeological community, it is used extensively elsewere.
Subsampling is useful when elements within sampling units

produce similar results; " . . . it seems uneconomical to measure them all" (Cochran 1963: 270). The procedure is quite straightforward. Sampling units which have been selected from a population are further divided into subsampling units. The sample is then selected from these secondary or subsampling units. The first stage sampling units are called "primary units" and the second stage units are referred to as "subsampling units".

This process may be carried to a third stage, however, this appears to be the extent to which statisticians like to take it (cf. Kish 1965; Cochran 1963).

Kish provides 4 justifications for subsampling and notes that it is generally used " . . . to divide larger clusters into smaller clusters"(Kish 1965: 156). Following Kish then, the 4 reasons are: 1) When natural clusters are too large to be economically sampled; 2) When one wishes to avoid the cost of creating smaller clusters; 3) If larger clusters have lesser "roh" values in computation of the effect of clustering; and 4) When sampling compact clusters offers practical difficulties.

In the design of any sampling exercise there exist a number of important decisions which must be made. These include determining the size, number and type of sampling units

as well as sample size. Perhaps one of the most useful bits of information to know prior to making these choices is the population variance (cf. Kish 1967: 49-52; Cochran 1963: 71-86). This would seem to be a difficult piece of knowledge to obtain given the fact that the reason you wish to sample is to obtain such information. There are, however ways by which gross approximations of population characteristics may be obtained prior to sampling. One of these is known as a pilot survey.

> . . . there are many points on which
> decisions can only properly be reached after
> preliminary investigation in the form of a
> "pilot survey" have been carried out (Yates
> 1960:39).

Pilot surveys have a number of functions. Yates (1960) describes the 2 most important of these: 1) To provide data on the components of variability the sampling population may be subject to; and, 2) To test the operation of the sampling scheme. He also notes that a pilot survey may provide important information about survey costs, the most effective sampling unit to use, or its size, or approximate characteristics of the population.

While Yates seems quite positive about pilot surveys Kish (1967) is much more reserved about their usefulness:

> Most studies are too small and too hurried to
> support a large enough "pilot sample" to yield
> useful estimates of S (unit variance), of
> variance components, and of cost factors (Kish
> 1967: 258).

and,

> . . . we cannot afford large enough pilot
> studies to provide better estimates than we can
> guess with the aid of past experience and
> expert advice. The pilot studies I know about
> are mostly "feasibility studies", testing the
> survey operations . . . (Kish 1967:
> 277-278).

Cochran (1963) appears to agree in part. He notes that the pilot survey can be useful in providing advance estimates of population variances to determine acceptable sample size. However, he cautions that if the pilot survey is restricted to a few clusters of units an underestimate of the population variance may result.

It would appear that while the pilot survey could be useful its cost might be too great in terms of both time and money. Cochran (1963) lists 3 other methods for obtaining data about the population in question: 1) By breaking the sample into 2 steps; 2) By using previous survey sampling results; and, 3) By making guesses about the structure of the population. He notes that the first of these gives the best results, but is not often used because it is time consuming. The second option is, of course, contingent upon the existence

of a previous sample survey. The third technique, while
obviously providing gross information, appears most appealing,
especially for areas not previously sampled. Cochran (1963)
and Deming (1960) suggest that if the population distribution
is known and if a range can be estimated, a rough approximation
of the variance may be calculated which in turn may be used to
provide information for the design of a survey sample (cf.
Cochran 1963; Deming 1960; Kish 1967).

Conservation Archaeology

Introduction

Recent public concern for environmental quality and a
general awareness of a steady depletion of various resources
due to exploitation and development of the natural landscape
has fortuned the archaeological community with additional
funding sources and opportunity for practical application of
its method and theory. Legislation specifically dealing with
heritage resources has been enacted and environmental impact
projects have increasingly included archaeological or heritage
studies within their groups. Heritage resources, including
both historic and prehistoric, have come to be widely
recognised and are referred to as non-renewable: a resource

that may be totally destroyed either intentionally by the
archaeologist or unintentionally through land development or
natural land modification processes. One of the major
outgrowths of this interest in protecting the natural landscape
and its cultural heritage has been the rather rapid development
of the concept cf cultural resource management (C.R.M.)
Dunnell 1979. This has become popular of late, and universities
and colleges in both Canada and the United States currently
offer courses or degrees specializing in C.R.M.

Policies have now been formulated aimed at management of
cultural resources and attempting to control unmitigated
environmental modification. As well, a general philosophy for
heritage conservation has been established (cf. King et al.
1977; McGimsey and Davis 1977; Schiffer and Gumerman 1977;
Schiffer and House 1975; 1977). The following discussion
reviews some of the problems inherent in cultural resource
management studies. In addition, this section strives to
present the general philosophy currently espoused in C.R.M.
studies and outlines their bases in British Columbia.

Conflicts in Cultural Resource Management Studies

Archaeology implemented under C.R.M. agreement, variously termed rescue, salvage, emergency, crisis, highway, corporate, conservation and public archaeology (Benson, 1976), has frequently been criticized as inadequate, the result of insufficient funding or inexperienced researchers (Broilo and Judge 1977: 2). This criticism has also resulted in an apparent dichotomy in the discipline, between "contract" workers and those who espouse "pure research" or science. King (1971) has succinctly outlined the central issue:

> In short, the problem was not that salvage was intrinsically bad, unscientific, or useless for explanatory research, but that the support agencies' orientation toward the reactive redemption of uncoordinated data, and the organizational structure appropriate to this orientation, operated counter to the needs of explanation (King, 1971: 259).

The solution, he suggests, lies in careful organization. On a somewhat different level, others have promoted the establishment of comprehensve research designs (eg. Schiffer and House 1975;1976).

> The historical division between "salvage" archaeologists and "academically oriented" archaeologists is no longer tolerable. Archaeology is archaeology whether it be conducted within the academic field school or

in less tranquil atmosphere of contract
obligation. The need for innovative and
elegant research strategies incorporating
multistage programs, and the implementation of
such projects, involves the articulation of all
forms of archeological specialists (Broilo and
Judge 1977:3).

However, concern about the quality of recent C.R.M. work
continues to appear in the literature (cf. Goodyear et al.
1978; King et al. 1977; Plog et al. 1979) and claims
regarding the value of C.R.M. research to the discipline are
largely voiced by one group, those actively engaged in
conservation studies (cf. Mayer-Oakes and Portnoy 1979;
Glassow 1977 ; Schiffer and Gumerman 1977). While it is
true that recent C.R.M. work has resulted in research
contributions (eg. Schiffer and House 1975; 1977; Schiffer and
Gumerman 1977; Spurling 1978), it is also true that
contributions have been made in the past, before the resurgence
of inspired interest in making contract work a redeeming
vocation. Doing research under the guise of conservation
archaeology is by no means a new phenomenon. And, it is also
true that significant contributions to the discipline have not
always come out of "pure research"; witness the "Ugly" of
Thomas' "The Good, Bad and the Ugly" (Thomas, 1978). It could
be considered a stand-off but the fact that contract work under
the philosophy of C.R.M. has produced some results coupled
with the knowledge that pure research efforts do not always
result in significant contributions does not quell the

arguments. There are still major difficulties in C.R.M. work which stand to clearly distinguish it from the other more traditional research endeavours.

The fact that C.R.M. contract work is done for money cannot be ignored.

> Much contract work is done by people primarily
> interested in financial gain or security of
> employment; as a result, both price-gouging and
> "whitewashing" of destructive projects occur
> (King et al. 1977: 189).

Another problem is the level of competence of the personnel who run agencies which oversee and regulate heritage resources. King et al. (1977: 190-191) have described this as a long range malady; a potential problem of over-regulation produced by those not capable or imaginative enough to deal more realistically with the problems at hand and whose solution will be to develop regulations which will inhibit research rather than promote or facilitate it.

Competition is another aspect of cultural resource management studies which may be considered a limiting factor. In competing for contracts, budgets may be cut too low in an effort to win. This has the obvious effect on the end product that only minimal results can be expected. Also, time spent by

contractors seeking follow-up contracts is time not spent on analysis or research. Contractors cannot afford to continue research on a problem after a job is finished. It is imperative that they begin a new contract in order to preserve their existence as a viable contracting agency.

Schiffer and Gumerman (1977) dogmatically argue that such views about cultural resource management studies do not hold substance.

> Not only can the irrelevance of these
> allegations be easily shown, but we can go on
> to list the unique advantages that are held by
> conservation archaeology research (Schiffer and
> Gumerman, 1977: 81).

They note that: 1) Restricted study area boundaries dictated by contract requirements do not necessarily restrict the ability to carry out meaningful research; 2) Problems of designing research to suit the data rather than the other way around may be dealt with through compromise; and, 3) That the funding and time arguments are " . . . ludicrous, given the chronic underfunding of academic research" (Schiffer and Gumerman 1977:81-82). Their first two responses are well taken. However, the third is difficult to accept. The fact that pure research is underfunded does not settle the issue. Schiffer and Gumerman (1977) admit that " . . . time

constraints on many projects on many projects are sometimes
debilitating" (1977: 82). Their response to this is that
the situation will get better in the future:

> But we can expect that as cultural resource
> management studies move out of the catch-up
> stage . . . this problem will resolve itself
> satisfactorily (Schiffer and Gumerman 1977:
> 82).

However, time and funding limitations are difficulties
which cannot be easily ignored, indeed, they are not the only
problems facing C.R.M. studies (cf. Dunnell 1979; Portnoy
1978). Together these restrictions stand to limit the
contributions cultural resource management studies can expect
to provide the discipline. But C.R.M fills a need which can
not be neglected or disregarded by the archaeological
community. Nothwithstanding the limitations and criticism of
C.R.M. work, it represents a conscious effort towards
controlling the quality and quantity of archaeological work
necessitated by environmental concern and land development.
The fundamental purpose of this effort is conservation and
preservation of the archaeological record which, in total, has
been termed a new approach.

The New Approach

> Anthropologists working on contract survey
> projects should regard their work as legitimate
> research, not just a way to support themselves
> or their graduate students. Planning a
> contract project, defining and implementing a
> field methodology, and evaluation properties
> should be recognised as exacting intellectual
> exercises, not mere bureaucratic requirements
> (King et al. 1977: 193).

One approach to cultural resource management studies which
appears to be gaining widespread acceptance calls for the most
up-to-date methods of inquiry within the requirements of the
funding or contracting agency. While this approach may seem
simplistic and straight-forward on the surface it has been
proposed only recently, necessitated by the amount of
C.R.M.-related work being carried out. As well, the approach
must be evaluated in light of problems with the quality of some
previous work. It is an attempt to bring together all
archaeological work done within a cultural resource management
framework under one philosophy; an attempt to organize and
manage conservation work rather than allow it to be carried out
on an ad hoc basis. This tack also calls for the establishment
of explicit research goals for each project rather than simply
attempting to satisfy the contract company's requirements,
which may not necessarily be consistent with those of the
archaeological community. This approach has been termed
"contract archaeology" (Schiffer and House 1975;1976), "public

archaeology" (McGimsey 1972), "Conservation Archaeology"
(Gumerman and Schiffer 1977) and "cultural resource
management" (Lipe and Lindsay 1974; McGimsey and Davis (1977).
McGimsey and Davis (1977: 28) identify it as "New Directions"
in the discipline. The general philosophy of the "new
direction" is concerned with the "management" of archaeological
(heritage) resources through judicious and innovative means of
research and conservation;

> . . . the emphasis is not on simply
> excavating to "save" the sites, but rather on
> protecting and utilizing the cultural remains
> to their fullest scientific and historic extent
> (Schiffer and Gumerman 1977: xix).

The implication is that very little decent work was
carried out prior to recent revelations. This seems a bit of
an overstatement; I am sure few researchers believe this to be
true. However it does serve to stress a need which has not
always been satisfied. In general, conservation archaeology or
cultural resource management strives to extract maximum amounts
of data and information from contract activities through the
recognition that archaeological resources are a non-renewable
commodity. Since it is unrealistic to attempt to prevent land
modification projects, cultural resource management or
conservation archaeology can best be undertaken within specific
problem oriented frameworks rather than on an ad hoc basis.
More precisely, the trend appears directed towards more

organization and judicious and careful planning which together are expected to provide the best results for the money and effort expended. Dunnell cautions, however, that this may cause the discipline to become overstructured by " . . . administrative regulations and bookkeeping conveniences" (Dunnell 1979:448-449) rather than by method and theory.

The Working Situation

The concept of cultural resource management in British Columbia and, indeed, Canada is not new but its practical application is. This is not only reflected in the fact that the legislation is relatively recent but in the nature of the legislation as well. There exist two specific references regarding the assessment of cultural resources in British Columbia. These are contained in the Environment and Land Use Committee's "Guidelines for Coal Development" (1976) and "Guidelines for Linear Development" (1977). They are, respectively:

> Archaeological and Historic Sites which will be
> lost to society in general, or a community
> which places special value on them, should be
> identified (E.L.U.C. 1976:20).

and,

(iv) Heritage Resources - Identification of
archaeological and historic sites. Impact of
development on heritage resources.
Identification of proposed short-term
mitigatory and compensatory measures (E.L.U.C.
1977:14).

Both of these are provided as descriptions of the " . .
. types of information and analysis to be included in the
description, evaluation and management of impacts" (E.L.U.S.C.
1977: 13). These are rather broad descriptions of what is
required in an assessment. In addition to these requisites,
more specific terms of reference and guidelines are often
required by the government agency in charge of a respective
resource (eg. Heritage Conservation Branch). Finally,
specific terms of reference are outlined by the contracting
agency itself. These usually echo the requirements of the
government agency in charge, and, as well, specically define
the area of study and kind of information wanted. Some danger
is inherent here in that the work could be oriented towards the
goals and requirements of the agencies rather than what might
be considered by the archaeologist to be desirable.

At the present time Alberta is the only province in Canada
which has legislation stipulating that environmental assessment
must be carried out prior to development projects (Land Surface
Conservation and Reclamation Act 1973). Whereas this is not
the case in British Columbia, there are, however, a number of

Acts which deal specifically with protection and
conservation of the resources (eg. Heritage Conservation Act
1977). While these Acts may require consideration of impact
assessment they do not make it a requirement (cf. Crook 1976).
This situation has been referred to as a "working situation"
(Crook pers comm.). Generally speaking, environmental
assessment in Canada occurs only when it is deemed by an
appropriate government agency to be necessary. Here the danger
is that environmental concerns could be conveniently overlooked
in the face of rising costs or expected opposition to projects
which are instrumental to government policy. In such instances
as these it becomes apparent that environmental concern is not
always as strong as the needs or wants that are perceived by
society or political groups to be of economic necessity.

In order to carry out archaeological work in British
Columbia the Heritage Conservation Act requires a permit,
issued by the Minister of the agency responsible. This permit
allows a researcher to initiate survey or investigations. The
Act attempts to protect heritage resources with the following:

 6 (1) No person shall remove, or attempt to remove,
 a designated object from the Province without the
 prior consent of the minister.

 (2) No person shall, except as authorized by a
 permit under section 5, knowingly

(a) destroy, desecrate, deface, move,
excavate, or alter a Provincial heritage site,
or a heritage object, designated under this
Part, or

(b) destroy, desecrate or alter a burial place
of historic or archaeologival significance or
remove skeletal remains from it, or

(c) destroy, deface or alter a North American
Indian kitchen-midden, shell heap, house- pit,
cave or other habitaion site, cairn cr
fortification (Heritage Conservation Act 1977: 2).

And in section 7:

(2) Where in the opinion of the minister, land
contains a heritage site, he may order a site
survey, or, where he considers circumstances
warrant, a site investigation.

(3) Where, in the opinion of the minister, a
heritage site may be altered, damaged, or destroyed
or is likely to depreciate or beccme delapidated, he
may order

(a) a site survey, or, where he considers
circumstances warrant, a site investigation,
and

(b) the owner of the heritage site

(i) to pay for the site survey or site
investigation, and

(ii) to preserve the heritage site until
the site survey or site investigation is
completed.

(4) Where a site survey or site investigation is
ordered under this section, it shall be taken
forthwith and in a manner that will not cause undue
hardship to the owner of the land.

(5) Where necessary to make a site survey or site
investigation ordered under this section, a person
may enter land and no action for loss, damage, or
trespass shall be brought for anything done or
omitted by him in good faith under this section
(Heritage Conservation Act 1977: 3).

The purpose of the Act is " . . . to encourage and facilitate the protection and conservation of heritage property in the Province" (Heritage Conservation Act 1977: 1). In this Act "heritage" refers to the following:

> . . . "heritage" means of historic, architectural, archaeological, paleontological, scenic significance to the Province or a municipality . . .

> . . . "heritage object" means, whether designated or not, personal property of heritage significance;

and,

> "heritage site" means, whether designated or not, land, including land covered by water, of heritage significance. . . (Heritage Conservation Act 1977: 1).

There exist several difficulties in the practical application of the "working situation". Simple enforcement of the legislation is difficult because it is almost impossible to oversee the activities of people over an entire province. Problems in legal interpretation of the Act further complicate conservation attempts. Inconsistencies within the method and theory of the discipline itself tend to confuse matters as well (cf. Goodyear et al. 1978; Plog et al. 1979). For example, significance is not defined in the Act and therefore some ambiguity exists in its interpretation. However, the definition, applicability and usefulness of the term in the

study of prehistory remain a major difficulty. The
"assessment of significance" is one of the current problems in
cultural resource management studies (cf. Lynott 1980). It is
primarily a definitional problem. While a statement of
significance is generally considered necessary in cultural
resource management studies, it is difficult to operationalize
the concept because the criteria required to describe
significance do not lend themselves to quantification easily.
Significance cannot be measured directly like temperature or
weight. In fact, there exists no ultimate set of criteria
which would allow the assessment of significance for all types
of heritage resources.

> . . . there are many different site
> characteristics . . . that may be used in
> significance evaluation - so many, in fact,
> that choices must inevitably be made. How do
> we go about selecting those attributes whose
> importance will always be high? In fact, there
> is no sure way of knowing whether the attribute
> we might select today will continue to be
> important, or will exhaust the number that
> could be become important. All we can do is to
> identify those attributes that have been and
> are now important to archaeology . . .
> (Glassow, 1977:418).

In summary, the working situation provides controls for
heritage resources through the Heritage Conservation Act, 1977.
Like other environmental legislation, this Act empowers
government to undertake protective measures, such as impact
assessment and mitigation projects, but only where it is viewed

necessary. The totality of problems, conflicts, new concepts
and legislative guidelines linked with C.R.M. studies stand to
distinguish them from other heritage or archaeological research
free of these concerns. However, the necessity of C.R.M. work
cannot be underrated as it attempts to contend with the problem
of conserving and preserving a non-renewable resource. It is
perhaps more profitable to view the development of C.R.M. as a
legitimate and inevitable response of the discipline
necessitated by natural economic growth and development.
Perceived within this framework, the problems and criticisms of
C.R.M. may be elevated beyond presumption and renounciation
and ultimately benefit the discipline as a whole.

The Northeast Coal Study In Context

> A predictive survey sets out to identify the
> types of historic properties present in a study
> area, and to determine the relationships
> between property types and easily identifiable
> features of the natural or cultural
> environment, such as altitude ranges, drainage
> characteristics, and transportation routes.
> From these observations it is possible to
> extrapolate to the entire study area, with some
> degree of accuracy, thus predicting where
> different types and numbers of properties will
> occur throughout the area. For planning
> purposes, these predictions can be used much as
> can absolute data on specific properties, as a
> basis for identifying preservation
> opportunities and as a way of recognizing
> potential conflicts between preservation needs
> and modern land-use requirements before they
> become actual (King et al. 1977:147).

In the Northeast Coal study ecological anthropology
provided the bases for attributing interactive relationships
between environmental variables and cultural manifestations.
Ultimately the environmental variables are employed to
extrapolate heritage potential to proposed development zones of
the study area. To facilitate the acquisition of heritage
resource information, a formal sampling design was chosen,
primarily because of the size and forested nature of the area.
The research was carried out within the context of cultural
resource management philosophy and, therefore, is dependent
upon the implicit limitations dictated by requirements of the
funding agencies and the existing legislation.

Chapter 3

RESEARCH DESIGN AND METHODS

Introduction

> Attempting to sample the lowland Maya jungle by
> .5Km^2 quadrats would border on lunacy. Even if
> you succeeded in actually doing it, no one
> would ever believe you (Flannery 1976:159).

In the Northeast Coal study the primary interest of the
Environment and Land Use Sub-Committee (E.L.U.S.C.) was to gain
information from the survey about heritage resources in the
proposed development areas to facilitate assessment and
planning decisions. Essentially, the E.L.U.S.C. wished to
know the likelihood that heritage resources exist or do not
exist within parts of a very large region. Originally, the
agency wished to know where all the heritage resources were
within the study area; an impossibility given the size and
nature of the area and time allowed for survey. It is not
always clear to non-archaeologists why it is impossible to
determine exact locations and populations of heritage
resources.

For these reasons a sampling scheme was devised, designed
specifically to produce satistically valid information for a
regional evaluation process. Other aspects of the project were
secondary to these concerns.

The use of a formal probabilistic sampling procedure for
archaeological survey in forested areas seems most appropriate
for the simple reason that only a portion of the total area
requires actual survey. Initially the advantages would seem
obvious. These advantages are, however, lessened by the fact
that vegetation cover in forested areas is usually too dense to
allow for unrestricted surface visibility. This makes sampling
both appealing and difficult because one of the implicit
requirements for successful sampling is. that the sampling unit
be completely examined. The decision to utilize sampling
procedures in forested areas becomes dependent upon the ability
of the researcher to adequately cover the sampling unit.

At the time of this study examples of probabilistic survey
in forested areas were few in number (eg. Lovis 1976). Lovis
(1976) sampled forested areas utilizing an observation
technique similar to that used here. Using one foot square
test units placed systematically at 100 yard intervals, quarter
section sampling units were surveyed. He reasoned that by
digging test units systematically throughout the sample unit it

would be adequately covered. One criticism of this systematic placement of excavation units is that it does not take into account periodicities which may occur in the data and therefore contribute bias to the results (Berry, 1962). Nance (1979) discusses several other problems with this study. These include: 1) Failure to acknowledge the design as a subsampling technique; 2) Failure to deal with cluster sampling when cluster sampling was in fact in use; 3) Incorrect use of chi-square statistic on cluster samples; and, 4) Using chi-square with samples which were too small in number (Nance 1979: 172-176).

The idea of digging test units within a survey area is not new in archaeology. The utility of this technique may be maximized, however, through careful consideration of their placement and sampling facilitates this.

Sampling Design and Methods

The N.E.C. study area was first stratified into smaller regions (corridors). Each of these regions was characterized by a set of environmental attributes (Table II) and then further subdivided into smaller areal units (Fig. 3). The
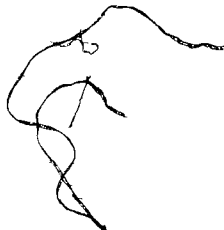
TABLE II

Environmental attributes used to describe corridor
regions of the study area.

Major Vegetation Zones
1.   i) Boreal White Spruce, Balsam Poplar Subzone
2.   ii) Boreal White Spruce, Black Spruce Subzone

Vegetation Types
3.   iii) Trembling Aspen
4.   iv) White Spruce
5.   v) Lodgepole Pine
6.   vi) Willow

Fish Species
7.   i) Grayling
8.   ii) Mountain Whitefish
9.   iii) Dolly Varden
10.   iv) Others (eg. suckers)

Geographical Features
11.   i) Major River
12.   ii) Major Creek
13.   iii) River - Creek Confluence
14.   iv) Creek Confluence
15.   v) Lake
16.   vi) Lake Creek Confluence
17.   vii) Lake River Confluence
18. viii) River Confluence

Known Heritage Resources
19.   i) Archaeological Sites
20.   ii) Historic Sites

49a

Figure 3 Corridor regions of the study area.

CORRIDOR REGIONS
OF THE
NORTHEAST COAL
STUDY AREA
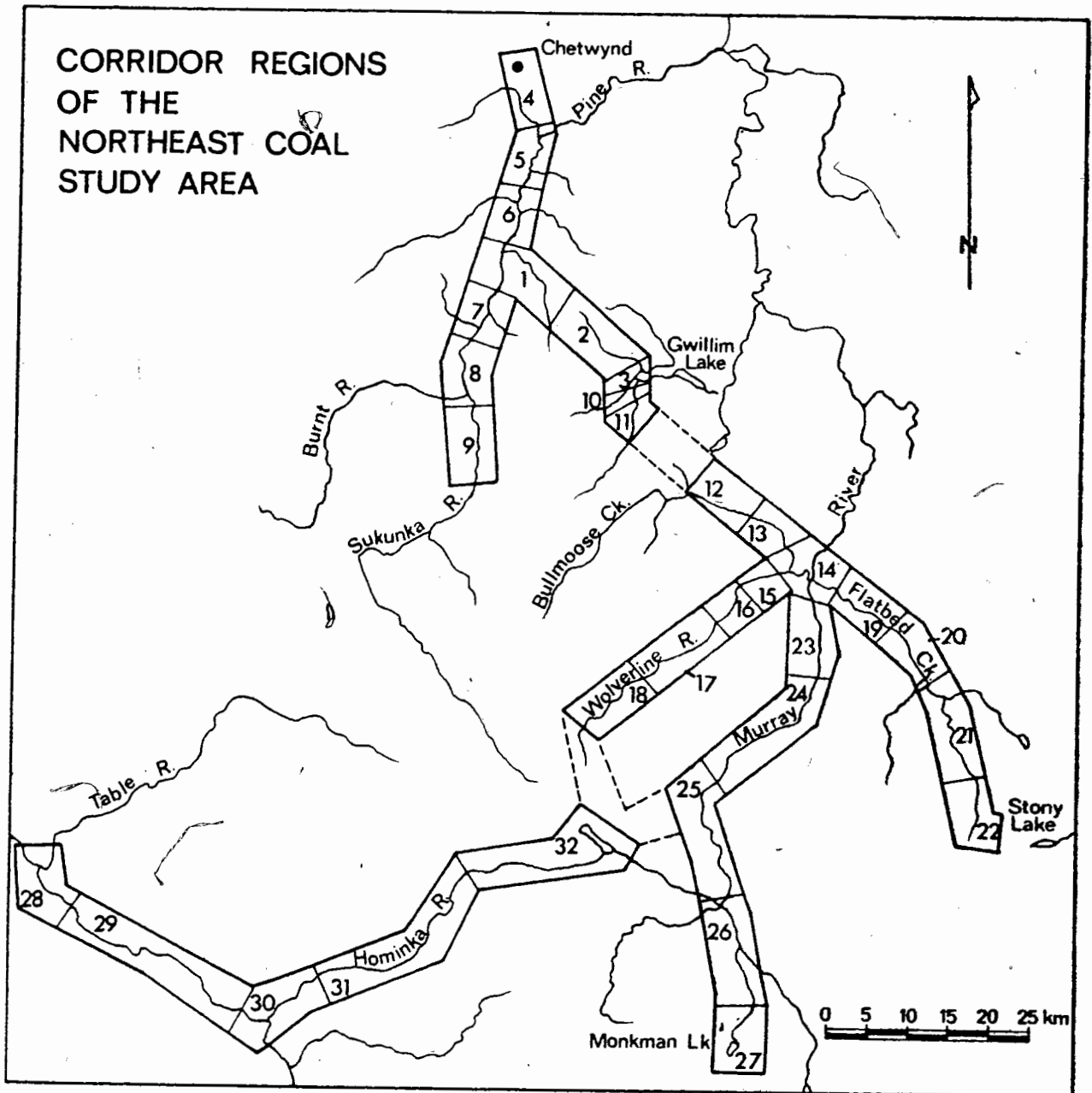
environmental attributes provide the bases for subsequent
regional comparison and heritage potential predictions. One of
the corridor regions was selected for sampling (Fig. 4). This
sampling area represents the population from which predictions
about the whole study area (universe) are made. The sampling
area is also referred to as the control region. This procedure
is based upon a sampling technique used by geographers in
regional studies. (cf. Berry 1962; 1968; Berry and Baker
1968).

Data on the presence and absence of environmental
attributes within the sub-regions of the study area were
obtained from Provincial Government resource maps, with the
exception of cases 19 and 20. It should be noted that at the
time this study was conducted resource information for some
parts of the study area was incomplete and not available.

Observation in the forested sample area was facilitated by
digging a series of test units throughout each sampling unit.
Locations of these test units were chosen using a stratified,
systematic, unaligned sampling technique (Berry 1962). This
appears to be a satisfactory method of solving the problem of
adequately covering a forested sampling unit (cf. Nance in
press a and b; Spurling 1978). This technique takes into

51a

Figure 4 Control corridor survey sampling area.

Martin Creek to Gwillim Lake
Survey Area

LEGEND

:::::	Survey Area	
----	Existing Road	
———	Northeast Coal Development Road	

Survey Quadrats

Stratum 1

Stratum 2

Stratum 3
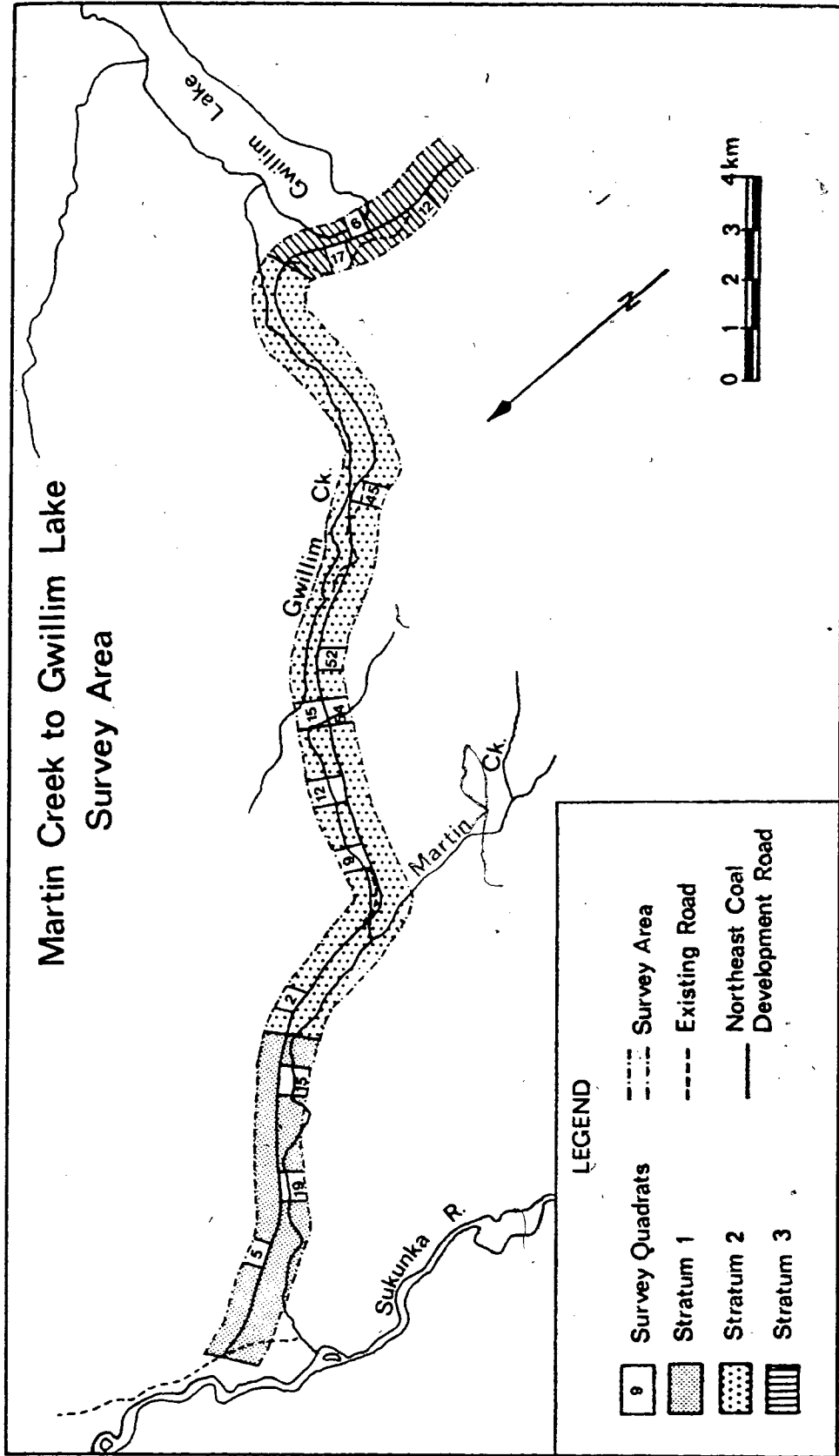
account any inconsistencies or periodicities in data within the
sampling unit and is therefore preferred over other systematic
selection methods. A pilot survey area (Fig. 5) was selected
near the base camp in order to: 1) Provide a test for the
sampling technique, that is, the observational technique of
digging holes throughout the sampling unit; and, 2) Provide
information which would be useful in the final choice of sample
size in the control sample area.

   To facilitate sampling the Martin Creek to Gwillim Lake
control region (Fig. 4), each stratum of the corridor was
first divided into N sampling units of equal size, 500 m on a
side, and a simple random sample of n of these was chosen
within each stratum. These units are referred to as primary
sampling units. Because the area was so densely forested and
therefore difficult to search using traditional techniques, the
primary sampling units were subdivided into M subunits, each 50
m on a side, and a sub-sample of size m selected. As noted
above, examination of these forested areas consisted of digging
small test or observational units throughout each sample unit.
A schematic representation of this sampling scheme is shown in
Figure 6.

   Thus, the sampling procedure employed may be described as
a disproportional stratified cluster sample design. The

53a

Figure 5   Pilot survey sampling area.

GWILLIM LAKE PILOT SURVEY AREA

GWILLIM LAKE

LEGEND

Survey Quadrats   3
Location of Cultural Material   •
Road   ------
Building   □

Contour Interval   5 metres

54a
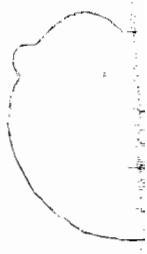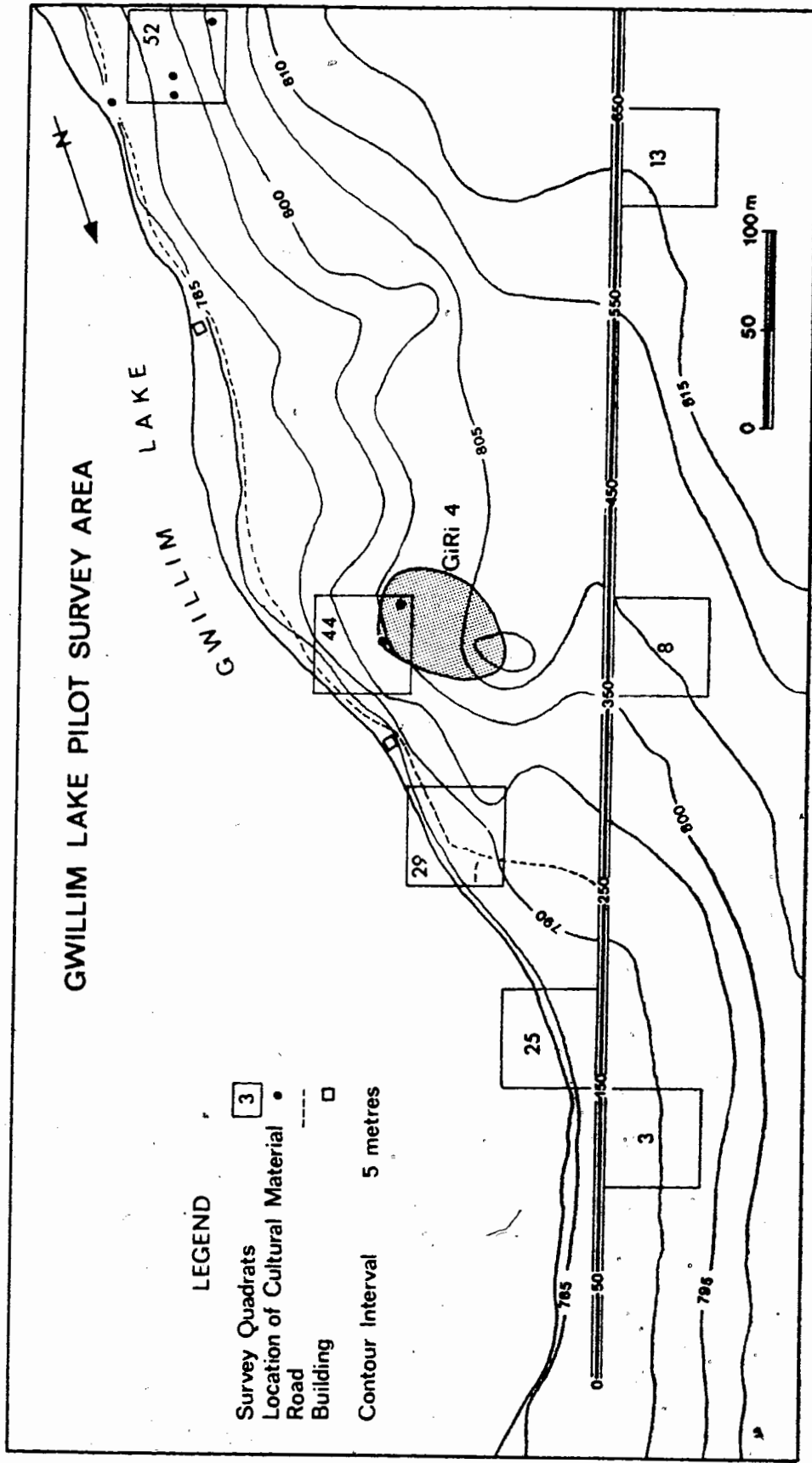
Figure 6   Sampling scheme.
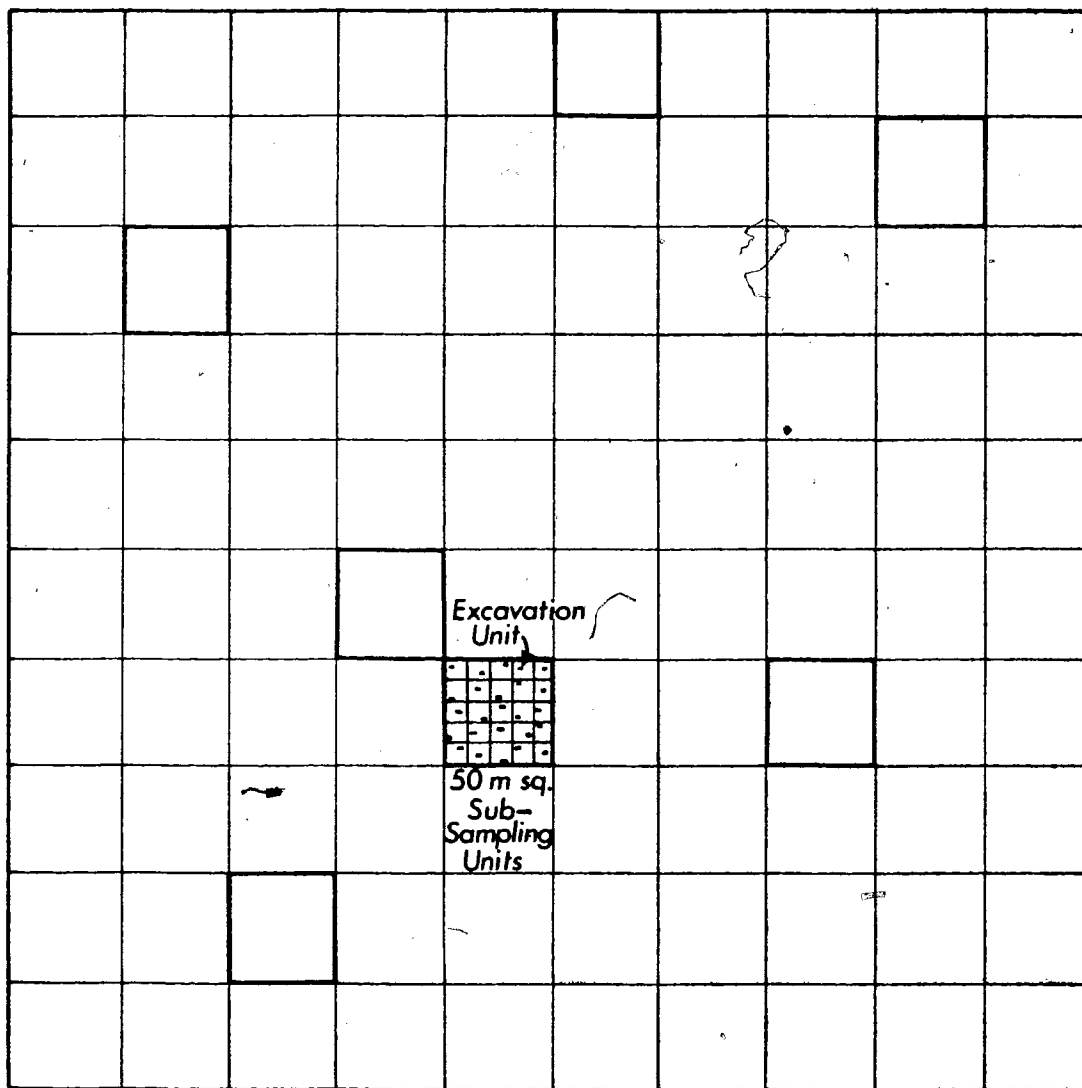
Excavation
Unit

50 m sq.
Sub-
Sampling
Units

500 m sq.
Primary Sampling Unit

Sampling Scheme

primary units (all of equal size) were subsampled and the subunits surveyed systematically using excavated test units (25 in each subunit). It was estimated that 25 test units placed within the confines of a 50 m square subunit would allow adequate and reliable coverage and the forested sampling unit would then be effectively and satisfactorily surveyed. Although this assumption has not been tested, Nance (in press, a and b) and Spurling (1978) have had success with units spaced even wider apart, 20 m and 100 m respectively. The test units were excavated using shovels and .64 cm mesh screens, and where cultural material was encountered, trowels were used for the remainder of the excavation.

Due to the nature of the terrain, it was not possible to cover all sample units adequately. In some instances, sampling units occurred in areas that were less than desirable for observation, not to mention prehistoric habitation. Such areas included steep slopes, cliffs and stream channels. These areas were observed to hold no evidence of cultural occupation.

Because of the nature of the survey (i.e. forest sampling) the research was designed to permit only the location of cultural material. Therefore, it was necessary to define a site to be any cultural items encountered within a sampling unit or survey area, be it an historic structure or a single

flake. As well, a limited time schedule restricted further determination of the extent of sites located; ideally this kind of investigation would be included in subsequent site specific work or other mitigation procedures.

Chapter 4

RESULTS OF SURVEY SAMPLING

Introduction

Results of the survey sampling are presented in this
chapter. These include 2 sets of data: 1) From the Gwillim
Lake pilot survey (Fig. 5), wherein the sampling technique was
tested; and, 2) From the Martin Creek to Gwillim Lake sampling
corridor (Fig. 4). These data are used to provide probability
statements or predictions about the other regions of the study
area.

Statistical Analysis

Estimates from the sampling exercise are of proportions of
areas containing cultural material rather than actual numbers
of sites. This is so because it was only possible to identify
cultural material within subsampling units and not define the
actual number of sites within any of the sampling units.
Archaeological survey sampling has in the past been primarily

concerned with making estimates of site numbers (cf. Mueller, 1974 ; 1975; Matson and Lipe, 1975, Judge et al., 1975). This is usually a relatively simple matter and all that is required, after design and selection of a sampling approach, is to survey the sampling unit and record the occurrence or non-occurrence of sites. The greater number of examples of surveys of this type originate in areas where the ground is not covered by dense vegetation and survey is straightforward; usually a simple process of visually searching the sampling unit.

The process is somewhat more difficult in forested situations where the search involves digging test units throughout the sample unit. The excavation of test units within the sampling unit results in observations of either the presence or absence of cultural material. Therefore, because estimates of numbers of sites cannot be made results are best presented as "Estimates of Proportions"; that is the proportion of the area estimated to contain cultural material as determined by the presence or absence of cultural material within subsampling units.

The estimate of the proportion "$\hat{p}$" is obtained by:

$$\hat{p} = \frac{\varepsilon \; x_i}{\varepsilon \; m_i}$$

where:

x_i = 1 if cultural material is present in a subunit and x_i = 0 if cultural material is absent from the subunit;

m_i = the number of subunits examined in a primary unit; and,

n = total number of primary units selected into the sample.

An estimate of the variance of $\hat{p}$ is:

$$S^2_{\hat{p}} = \frac{1 - f_1}{n(n - 1)} \Sigma(p_i - \hat{p})^2 + \frac{f_1(1-f_2)}{n^2(\bar{m} - 1)} \Sigma p_i q_i$$

where:

$f_1 = \frac{n}{N}$;

$f_2 = \frac{m}{M}$;

p_i = the estimate of the proportion for each of the n primary units; and,

$q_i = (1 - p_i)$.

Estimates of sample size may be obtained from information gained in previous samples (eg. Pilot surveys) or, when this

is not possible, from." . . . guesswork about the structure
of the population" (Cochran 1963: 77) under consideration
(see also Deming 1960). These estimates of sample sizes for an
infinite population are provided by

$$n = (\text{Desired Confidence}/\text{Desired Precision})^2 \, \hat{p}q$$

where:

n = the estimated sample size;

$\hat{p}$ = the estimate of proportion; and,

$q = (1 - \hat{p})$.

The 'Desired Confidence' is the confidence limits (eg. 2.58
and 1.96 for 99% and 95% confidence respectively) and the
'Desired Precision' is the expected error (eg. +/- .01 or
+/- .05) (cf. Cochran 1963: 71-84).

This estimate assumes that the subsampling procedure
employed provided an adequate assessment of the
presence/absence of cultural materials in primary units.

Pilot Survey Results

In order to chose a sample size which will provide
reliable results it is desirable to first know something about
the population under consideration. As noted above,
information about the population may be obtained from previous
survey data. Even nonprobabilistic survey data can provide
gross information. Sample size estimates for the Gwillim Lake
pilot survey are shown in Tables III. These primary unit
sample size estimates were obtained from the Fellers Heights
area (Fig. 2). Placing a grid network of 500 m units over a
portion of the Fellers Heights area which had been surveyed
previously in 1976, known site locations were plotted within
the grids. The result of this was that a total of x = 6 sample
units out of a possible n = 33 contained cultural material.
The estimate of the proportion from this information is:

$$\hat{p} = \frac{x}{n} = \frac{6}{33} = .182$$

TABLE III

Sample size estimates for the Gwillim Lake
pilot survey area.

		% Confidence		
		99	95	90
	.05	10	6	5
	.10	3	2	1
Precision	.15	1	1	1
	.20	1	1	1

A sample size of 7 primary units was chosen for Gwillim
lake pilot survey. The results of this survey are shown in
Table IV.

TABLE IV

Sampling results from the Gwillim Lake pilot survey.

Population Size	69
Sample Size	7
x	2
$\hat{p}$	.286
Variance of $\hat{p}$	.034

The exercise was completed over a period of 9 days, with 8
people working on it intermittently. This works out to about
1.3 days for a sampling unit in which 25 test units are
excavated. From this it was estimated that a maximum of 30
subsampling units (each 50 m square) could be completed in the
control survey sampling area.

Control Corridor Results

Estimates of sample sizes for the control survey sampling area, based on the results from the pilot sample, are shown in Tables V, VI, and VII. The population sizes for the 3 strata in the control corridor survey area were: 26 in stratum 1, 67 for stratum 2 and 18 for stratum 3. Within these, a total of 36 subsampling units were surveyed. This included; 6 in statum 1, 14 in stratum 2, and 16 stratum 3. The results of survey sampling in the control corridor are shown in Table VIII.

TABLE V

Estimates of sample size for Stratum 1 of the control survey sampling region.

		% Confidence		
		99	95	90
	.05	20	17	15
	.10	12	9	7
	.15	7	5	4
Precision	.20	5	3	2
	.25	3	2	1
	.30	2	1	1
	.35	2	1	1
	.40	1	1	1

TABLE IV

Estimates of sample size for Stratum 2 of the control survey sampling region.

		% Confidence		
		99	95	90
	.05	39	29	24
	.10	17	11	8
	.15	9	5	4
	.20	5	3	2
Precision	.25	3	2	1
	.30	2	1	1
	.35	2	1	1
	.40	1	1	1

TABLE VII

Estimates of sample size for Stratum 3 of the control survey sampling region.

		% Confidence		
		99	95	90
	.05	15	13	12
	.10	10	8	6
	.15	6	4	3
Precision	.20	4	3	2
	.25	3	2	1
	.30	2	1	1
	.35	2	1	1
	.40	1	1	1

Table VIII

Sampling results from the control survey sampling area, Martin Creek to Gwillim Lake.

	Sample Stratum 1	2	3
Population Size (N)	26	67	18
Number cf Primary Units Selected (n)	3	7	3
Total Number of Subsampling Units Selected (Σm)	6	14	16
Σx_i	1	0	2
$\hat{p}$	.167	-	.125
Variance of $\hat{p}$ ($S^2 \hat{p}$)	.078	-	.022
Standard Error of (S.e.$\hat{p}$)	.28		.15

Resource Potential Predictions

Determining heritage resource potential within the study area is achieved by applying the results of the survey sampling area to the other corridor regions. To do this it is necessary to first determine similarity among the respective regions. Comparisons were made between the 3 control corridor strata and the other corridor areas based on the presence or absence of the environmental attributes (Table II) scored for each area. Similarity measures were computed using a distance coefficient (ie. $1 - Sj$) (Sj = Jaccard's Coefficient, see Sneath and Sokal 1973: 131). The computations were made using a cluster analysis program (NT-SYS) on the IBM 370/55 computer facilities at Simon Fraser University. Results are shown in Table IX.

TABLE IX

List of similarity measures obtained from comparing
control strata with the other corridor regions
of the study area.

	Area	Stratum 1	2	3
4	CHET	0.214	0.667	0.471
5	TWID	0.375	0.600	0.500
6	DICK	0.071	0.533	0.353
7	BRSH	0.250	0.467	0.294
8	BRNT	0.313	0.625	0.444
9	SKET	0.267	0.600	0.412
10	MENO	0.471	0.385	0.313
11	MESO	0.375	0.385	0.313
12	BUWS	0.600	0.667	0.706
13	BUES	0.533	0.583	0.647
14	TUMB	0.444	0.467	0.389
15	2CRK	0.375	0.250	0.412
16	WOL1	0.500	0.273	0.529
17	WCL2	0.563	0.615	0.667
18	WOL3	0.533	0.300	0.467
19	FLT1	0.600	0.400	0.533
20	FLT2	0.467	0.364	0.400
21	HAMB	0.556	0.500	0.412
22	UPFL	0.647	0.364	0.400
23	TMSO	0.333	0.462	0.471
24	MURY	0.471	0.600	0.500
25	KINS	0.500	0.417	0.529
26	IMPR	0.444	0.467	0.389
27	MONK	0.786	0.727	0.643
28	PRTB	0.500	0.417	0.529
29	PRSP	0.533	0.692	0.722
30	PRHM	0.688	0.545	0.706
31	HOMK	0.714	0.700	0.813
32	HOHK	0.875	0.917	0.813

The low values in Table IX indicate the greatest similarity between any of the strata and a corridor area. Rearranging these data slightly, the areas displaying the greatest similarity to each of the respective strata are shown in Table X. Figure 7 is a heritage potential map of the Northeast Coal study area graphically presenting the data shown in Table X.

TABLE X

List of corridor areas aligned beneath the control strata for which they displayed greatest similarity.
Numbers in the brackets show the degree of similarity between the Strata and the respective corridor areas with the low values indicating greatest similarity.

Stratum 1			Stratum 2			Stratum 3		
4	CHET	(.2)	15	2CRK	(.3)	10	MENO	(.3)
5	TWID	(.4)	16	WOL1	(.3)	11	MESO	(.3)
6	DICK	(.1)	18	WOL3	(.3)	14	TUMB	(.4)
7	BRSH	(.3)	19	FT1	(.4)	21	HAMB	(.4)
8	BURNT	(.3)	20	FT2	(.4)	26	IMPR	(.4)
9	SKET	(.3)	22	UPFL	(.4)	27	MONK	(.6)
12	BULWS	(.6)	25	KINS	(.4)	32	HOMK	(.8)
13	BULES	(.5)	28	PRTB	(.4)			
17	WOL2	(.6)	30	PRHM	(.5)			
23	TUMBS	(.3)	31	HOMK	(.7)			
24	MURY	(.5)						
29	PRSP	(.5)						

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Figure 7   Heritage potential within development

corridors of the study area.

HERITAGE POTENTIAL WITHIN DEVELOPMENT CORRIDORS OF THE NORTHEAST COAL STUDY AREA

LEGEND

Sampling Area (1, 2, 3)

Regions Similar to Area 1

Regions Similar to Area 2

Regions Similar to Area 3

Chetwynd

Pine R.

Gwillim Lake

River

Flatbed Ck.

Stony Lake

Table R.

Hominka R.

Murray R.

0 5 10 15 20 25 km

N
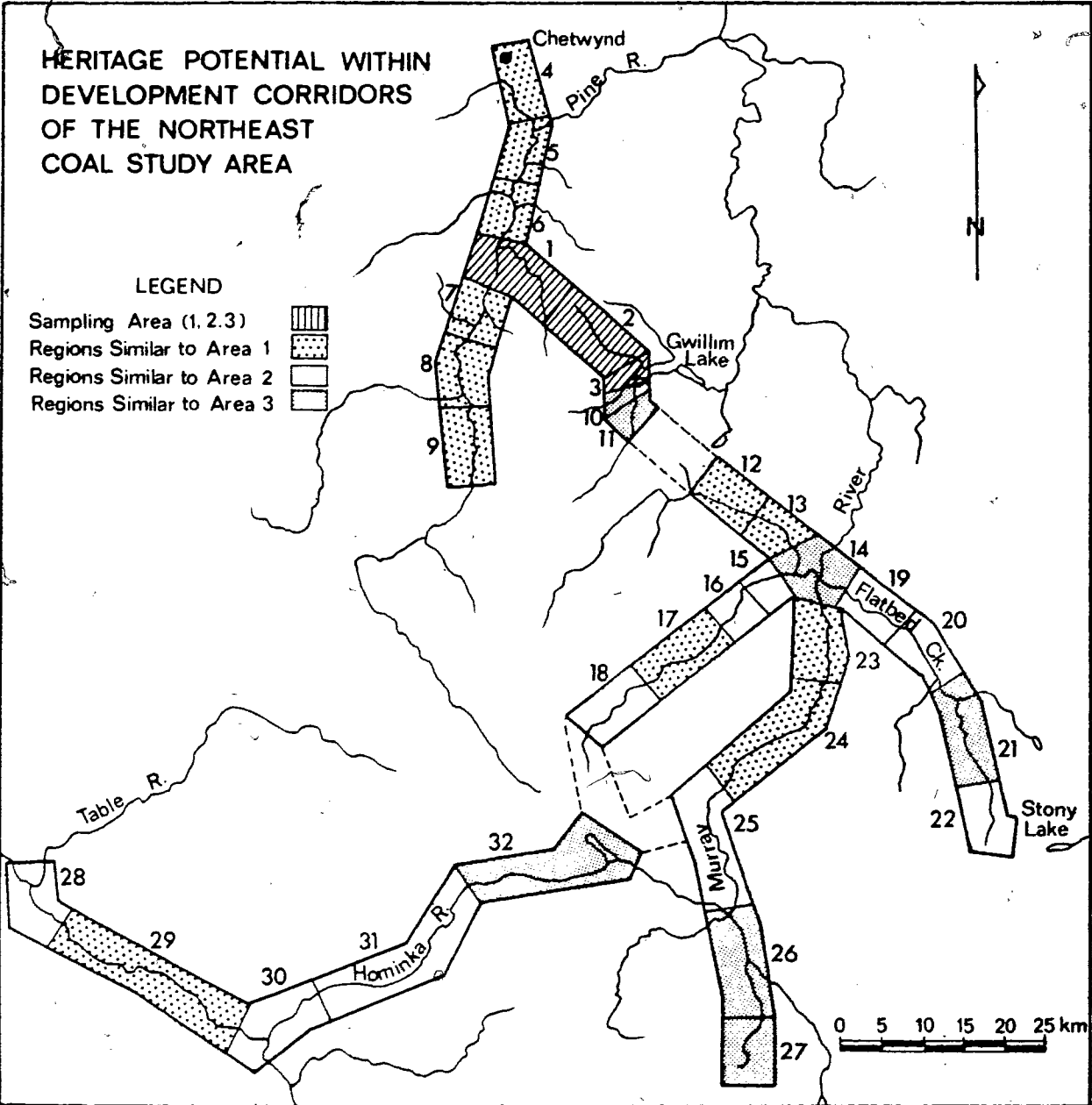
Chapter 5.

SUMMARY AND CONCLUSIONS

Overview

This study has been concerned with a regional sampling design aimed at providing information about heritage resources in the Northeast Coal study area. This information is meant to provide input for heritage resource evaluation in the region. A sampling design is presented which allows predictions to be made about heritage resources within a very large forested region. The use of probabilistic sampling is considered the most appropriate technique for approaching a regional cultural resource evaluation as required for the Northeast Coal study. Ecological anthropology and probabilistic sampling provide the theoretical basis for the study. A discussion of cultural resource management and conservation archaeology outlines some of the problems facing these types of heritage studies.

One of the difficulties confronting cultural resource management studies concerns the limitations placed upon them by virtue of their nature as a practical application of the method and theory of archaeology. Time and budgetary limitations

defined by aspects of C.R.M. work, such as the type of development (ie. large or small scale), size and shape of study area (pipeline or coal lease area), contract competition and the need to acquire future contracts to ensure continued income and company profit, place it apart from other archaeological research, often referred to as "pure research". This is not to say that "pure research" projects are not confined by problems but that the limitations are quite different. Their success is perhaps more closely aligned with the skill of the researcher, both in securing funds and carrying out the research.

Although cultural resource management work is encumbered by restrictions it remains the best means to approach conservation and protection of that portion of the archaeological record endangered by various land modification projects. In many ways its problematical character may be ascribed to its recent and rapid development. Many researchers have found it difficult to deal with C.R.M. because it is new and operates in some respects counter to the accepted canons of archaeological method and theory. Continued development of the natural landscape will ensure cultural resource management studies maintain an important position in the study of prehistory. Its ultimate success in contributing to the discipline, however, lies perhaps more with its critics than with its practioners and supporters.

> The rapid development of CRM has to a certain
> degree upset the normal progress of
> disciplinary development because it threatens
> to make permanent the condition of the
> discipline at a time in which rigidity is least
> warranted. The burden of the next few years is
> not, however, with CRM but with the profession
> as a whole which must resolve basic issues so
> that CRM can effectively insure the
> discipline's future (Dunnell 1979: 449).

In summary, the regional sampling design presented in this thesis provides information for heritage evaluation within a rather formidable study area. Results from the sample survey show that nineteen portions of the study region exhibit some heritage potential. Twelve of these show greatest similarity to stratum 1 of the sample area and 7 to stratum 3. Those areas displaying optimum similarity with stratum 2 are believed to hold little or no potential for containing heritage resources. Figure 16 is a heritage potential map of the Northeast Coal study area based on the information from the sample. It is estimated that 17% +/- 28 of the sample area in stratum 1 contains cultural material. A more precise estimate comes from stratum 3 with the results indicating that about 12.5% +/- 15 of the sample area contains cultural material. In this sense, the research contributes information useful for assessing environmental impact, planning for road, rail and other developments, as well as designing further heritage studies in the study area.

Results of this study also provide information useful for
researchers undertaking survey in areas with similar forested
conditions. The sampling scheme presented is a successful
method of treating forested survey tracts.

Evaluation of N.E.C. Project

Archaeological survey in forested areas is difficult and
no less so utilizing a formal sampling strategy. One of the
main objectives of the archaeological research in the Northeast
Coal study was to evaluate heritage resource potential within
defined areas. To the extent that this objective was
accomplished the research may be considered successful.
Success may also be measured in the utility of the predictive
model and the sampling scheme for future research projects.
However, there are some important practical considerations
which should be made.

Logistics is always a major concern in the initiation and
operationalization of any archaeological project. Problems
encountered with survey in areas where access is minimal are
complicated when the region is covered by forest. This becomes
especially true when formal sampling schemes are to be
employed. Difficulties may be experienced in locating sampling

research results provided in this thesis are presented as a
modest contribution to those heritage conservation efforts and
the study of prehistory.

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